CLAIMS

What is claimed is:

1. A magnetoresistive sensor for use in a data storage device, said sensor comprising a recessed sensing element and a flux guide that magnetically connects said sensing element to a sensing surface of the sensor, said sensing element and said flux guide having respective longitudinally biased active free layer regions formed by exchange biasing a ferromagnetic free layer outside respective track width boundaries of said sensing element and flux guide.

2. A magnetoresistive sensor in accordance with Claim 1 wherein said sensing element is constructed as one of a magnetic tunnel junction device or a current-perpendicular-to-plane spin valve device.

3. A magnetoresistive sensor for use in a data storage device, said sensor comprising a recessed sensing element with an active free layer region formed by exchange biasing a ferromagnetic free layer, and a flux guide that magnetically connects said sensing element to a sensing surface of the sensor, said flux guide being provided by extending said free layer active region from a front edge of said sensing element to said sensor surface, said sensing element and said flux guide being self aligned with substantially equal track widths so that magnetic flux directed from said flux guide into said sensing element is not diluted with consequent loss of sensitivity.

4. A magnetoresistive sensor in accordance with Claim 3 wherein said sensing element is constructed as one of a magnetic tunnel junction device or a current-perpendicular-to-plane spin valve device.

5. A magnetoresistive sensor for use in a data storage device, said sensor comprising:

a sensing surface adapted to be aligned substantially parallel to a magnetic recording medium of said data storage device;

a sensing element recessed from said sensing surface;

an electrically conductive fixed ferromagnetic layer (pinned layer) forming a first layer of said sensing element, said fixed ferromagnetic layer having a front edge recessed from said sensing surface and a back edge;

a barrier layer disposed on said pinned layer and forming a second layer of said sensing element, said barrier layer having a front edge recessed from said sensing surface and a back edge;

an electrically conductive sensing ferromagnetic layer (free layer) disposed on said barrier layer and forming a third layer of said sensing element and a flux guide, said free layer having a front edge located at said sensing surface and a back edge;

said free layer having a sensing element portion providing said third layer of said sensing element and extending from said barrier layer front edge to said barrier layer back edge;

said free layer having a flux guide portion providing said flux guide and extending at least from said free layer front edge to said barrier layer front edge;

said sensing element and flux guide portions of said free layer having respective magnetically responsive regions (active free layer regions) disposed between a pair of common track width boundaries that define sensing element and flux guide track widths which are substantially equal to each other; and

first and second electrically conductive shields respectively disposed to provide an electrical current through said fixed and free layers of said tunnel junction and across said barrier layer thereof.

6. A magnetoresistive sensor in accordance with Claim 5 wherein said sensing element is constructed as one of a magnetic tunnel junction device or a current-perpendicular-to-plane spin valve device.

7. A sensor in accordance with Claim 5 wherein said sensing element and flux guide active free layer regions are longitudinally biased in a direction substantially parallel to said sensing surface in the absence of an external magnetic field.

8. A sensor in accordance with Claim 7 wherein said longitudinal bias is provided by an exchange bias layer disposed under said free layer on either side of said sensing element and flux guide active free layer regions.

9. A sensor in accordance with Claim 8 wherein said exchange bias layer has inner side edges that define said track width boundaries.

10. A sensor in accordance with Claim 9 wherein said free layer includes a sub-layer and a top-layer, said sub-layer being formed between said exchange bias layer inner side edges and said top-layer extending over said exchange bias layer so as to be magnetically pinned outside of said sensing element and flux guide active regions and so that said sub-layer and said top-layer are longitudinally biased within said sensing element and flux guide active regions.

11. A sensor in accordance with Claim 10 wherein said sub-layer and said exchange bias layer are of substantially equal height where they meet at said track width boundaries.

12. A sensor in accordance with Claim 5 further including an exchange biasing layer disposed under said pinned layer.

13. A sensor in accordance with Claim 5 wherein said fixed layer and barrier layer front edges are spaced from said sensing surface by a substantially equal amount.

14. A sensor in accordance with Claim 5 further wherein said fixed layer and barrier layer back edges are spaced from said sensing surface by a substantially equal amount and

wherein said free layer back edge is spaced further from said sensing surface than said fixed layer and barrier layer back edges.

15. A sensor in accordance with Claim 5 further including an insulative layer extending from said sensing surface to said fixed layer and barrier layer front edges.

16. A sensor according to Claim 5 wherein said sensor is formed as a magnetic read head and is combined with a magnetic write head in an integrated read/write head.

17. In a disk drive having a housing, a rotatable magnetic recording medium in the housing, an actuator carrying an actuator arm, a suspension, and a read/write head disposed in adjacent relationship with the recording medium, an improved magnetoresistive read sensor within the read/write head, comprising:

a sensing surface adapted to be aligned substantially parallel to a magnetic recording medium of said data storage device;

a sensing element recessed from said sensing surface;

an electrically conductive fixed ferromagnetic layer (pinned layer) forming a first layer of said sensing element, said fixed ferromagnetic layer having a front edge recessed from said sensing surface and a back edge;

a barrier layer disposed on said pinned layer and forming a second layer of said sensing element, said barrier layer having a front edge recessed from said sensing surface and a back edge;

an electrically conductive sensing ferromagnetic layer (free layer) disposed on said barrier layer and forming a third layer of said sensing element and a flux guide, said free layer having a front edge located at said sensing surface and a back edge;

said free layer having a sensing element portion providing said third layer of said sensing element and extending from said barrier layer front edge to said barrier layer back edge;

said free layer having a flux guide portion providing said flux guide and extending at least from said free layer front edge to said barrier layer front edge;

said sensing element and flux guide portions having respective magnetically responsive regions (active regions) disposed between a pair of common track width boundaries that define sensing element and flux guide track widths which are substantially equal to each other; and

first and second electrically conductive shields respectively disposed to provide an electrical current through said fixed and free layers and across said barrier layer.

18. A magnetoresistive sensor in accordance with Claim 17 wherein said sensing element is constructed as one of a magnetic tunnel junction device or a current-perpendicular-to-plane spin valve device.

19. A method for fabricating a magnetoresistive sensor having a recessed sensing element and a flux guide formed by an extension of a free layer of the sensing element, the method comprising the steps of:

forming a multi-layer wafer which includes layers that will serve as said sensing element and said flux guide; and

defining a track width for said sensing element and said flux guide in a single photo processing operation.

20. A method in accordance with Claim 19 wherein said sensing element is constructed as one of a magnetic tunnel junction device or a current-perpendicular-to-plane spin valve device.

21. A method in accordance with Claim 19 wherein said multi-layer wafer forming step includes forming a wafer having an antiferromagnetic layer, a ferromagnetic layer (pinned layer) disposed on said antiferromagnetic layer, a barrier layer disposed on said pinned layer, a sensing ferromagnetic sub-layer (free sub-layer) disposed on said barrier layer, and a cap layer.

22. A method in accordance with Claim 21 wherein said photo processing operation includes applying a photoresist mask on said wafer to define a self-aligned sensing element and flux guide having active regions disposed between a pair of common track width boundaries that define sensing element and flux guide track widths which are substantially equal to each other.

23. A method in accordance with Claim 22 further including removing said cap layer, said free sub-layer, said barrier layer and said pinned layer from areas thereof that are outside of said active regions to expose a corresponding area of said antiferromagnetic layer.

24. A method in accordance with Claim 13 further including forming a insulating layer over said exposed area of said antiferromagnetic layer, said insulating layer being of sufficient thickness to cover exposed portions of said pinned layer and said barrier layer along said track width boundaries.

25. A method in accordance with Claim 24 further including forming an exchange bias layer over said insulating layer and removing said photoresist mask and said cap layer to expose said free sub-layer within said track width boundaries while leaving said exchange bias layer intact outside of said track width boundaries.

26. A method in accordance with Claim 25 further including applying additional free layer material over said wafer, including said free sub-layer and said exchange bias layer, whereby said additional free layer material completes said sensing element and said flux guide active regions within said track width boundaries and provides an exchanged biased free layer outside of said track width boundaries that longitudinally biases said active regions to a selected magnetic orientation in the absence of an external magnetic field.

27. A read head having a magnetoresistive sensor for use in a data storage device, said sensor comprising:

a sensing surface adapted to be aligned substantially parallel to a magnetic recording medium of said data storage device;

a sensing element recessed from said sensing surface;

a first magnetic shield layer;

an antiferromagnetic layer disposed over said first shield layer;

an electrically conductive fixed ferromagnetic layer (pinned layer) forming a first layer of said sensing element, said fixed ferromagnetic layer being disposed on said antiferromagnetic layer and having a front edge recessed from said sensing surface and a back edge;

a barrier layer disposed on said pinned layer and forming a second layer of said sensing element, said barrier layer having a front edge recessed from said sensing surface and a back edge;

an electrically conductive sensing ferromagnetic layer (free layer) disposed on said barrier layer and forming a third layer of said sensing element and a flux guide, said free layer having a front edge located at said sensing surface and a back edge;

said free layer having a sensing element portion providing said third layer of said sensing element and extending from said barrier layer front edge to said barrier layer back edge;

said free layer having a flux guide portion providing said flux guide and extending at least from said free layer front edge to said barrier layer front edge;

said sensing element and flux guide portions of said free layer having respective magnetically responsive regions (active free layer regions) disposed between a pair of common track width boundaries which define sensing element and flux guide track widths that are substantially equal to each other;

a second shield layer disposed over said free layer;

said first and second shield layers being adapted to provide an electrical current through said fixed and free layers of said sensing element and across said barrier layer thereof;

said sensing element and flux guide active regions being longitudinally biased in a direction substantially parallel to said sensing surface in the absence of an external magnetic field;

said longitudinal bias being provided by an exchange bias layer disposed under said free layer on either side of said sensing element and flux guide active free layer regions;

said exchange bias layer having inner side edges that define said track width boundaries;

said free layer including a free sub-layer and a free top-layer, said free sub-layer being formed between said exchange bias layer inner side edges and said free top-layer extending over said exchange bias layer so as to be magnetically pinned outside of said flux guide and sensing element active free layer regions and longitudinally biased within said sensing element and flux guide active free layer regions;

said free sub-layer and said exchange bias layer being of substantially equal height where they meet at said track width boundaries;

said fixed layer and barrier layer front edges being spaced from said sensing surface by a substantially equal amount;

said fixed layer and barrier layer back edges being spaced from said sensing surface by a substantially equal amount and said free layer back edge being spaced further from said sensing surface than said fixed layer and barrier layer back edges;

an insulating layer extending from said sensing surface to said fixed layer and barrier layer front edges; and

an insulating layer extending rearwardly of said fixed layer and barrier layer back edges and rearwardly of said free layer back edge.

28. A magnetoresistive sensor in accordance with Claim 27 wherein said sensing element is constructed as one of a magnetic tunnel junction device or a current-perpendicular-to-plane spin valve device.